Implementing Energy Star

features on

Network Computer Equipment

Prepared for

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Introduction

Throughout the world manufacturers are being encouraged to incorporate energy saving features into the design of their equipment. The U.S. EPA Energy Star programme provides manufacturers with guidelines for achieving this. Many computer manufacturers now incorporate these features and are 'Energy Star' compliant. In New Zealand the EECA will be promoting the use of equipment that comply with energy saving standards, and encouraging suppliers to provide the products with these features enabled by default when shipped to customers.

Such energy saving features have been the cause of some concern for organisations that operate a Local Area Network (LAN). As a result many have simply turned off, or not enabled these options, rather than address the issues brought about by enabling these features.

The purpose of this report is to examine the implications associated with implementing Energy Star features on computer equipment operated on a network. We examine each of the features, what purpose the feature serves and what effect it can have on the computer's network operation.

The report objective is also to provide product vendors and computer network administrators with guidelines and considerations so that they can consider implementing the Energy Star features within their equipment while still providing a reliable network computer system for client users.

The report does not, however, discuss the justification or arguments regarding why organisations should consider implementing an Energy Star policy. The advantages, both financially to the client organisation as well as the country, in terms of resource economics and the environmental effects, are already well addressed in other documents available from the EECA and many other organisations.

Energy Star Features

The exact nature of how energy saving features have been incorporated into computer equipment varies according to the manufacture of the equipment. In most PC computers available today, the features are incorporated into the ROM BIOS (Basic Input/Output System) of the computer and is set-up by either using software or by entering into the 'BIOS Set-up' of the computer.

Complex power saving features were once only found in Notebook computers in an effort to conserve battery life. However, with more organisations requiring 'EPA Energy Star' compliance, more manufacturers are now incorporating these features into their desktop computers and monitors.

Below is a general description of the Energy Star features that might be found in many brands of computer equipment. To find out more about how these features are implemented on specific brands of computer equipment, either contact the supplier or refer to the equipment's user manual. Advice should be first obtained from the supplier or manufacturer of the computer equipment before making changes to Energy Star settings, particularly if this involves entering into the BIOS set-up of the computer.

Computer Equipment

Energy Star compliant computers are required to have low power consumption during normal operation plus are required to incorporate power management to significantly reduce power consumption during non use after a preset timeout period. To be compliant they are also required to have power management features enabled before shipping with initial default timeout periods set-up.

The key components that are controlled by power management are generally:

- Monitor power control (VESA DPMS)
- Power management of the hard disk, floppy drive and CD-ROM drive.
- Power management of optional plug-in devices such as modem cards.
- CPU and peripheral 'Sleep' modes.
- 'Stand-by' and 'Suspend' modes - generally only found on Notebook computers but now beginning to emerge on desktop systems.
- Complete power down

The computer's power management control settings should provide for enabling or disabling each of these features and for setting up various timeouts for each.

Computer monitors that are Energy Star compliant incorporate features that reduce the power consumption either on the detection of no video signal from the computer or they can be signalled by the computer (DPMS) to switch into a low power operation after a preset timeout. This can be done in two steps; one, reducing the display intensity, and then two, suspending the monitor into a minimum power mode with no display. Energy Star monitors are often provided with a software disk to allow the Energy Star feature to be used on computers that do not have the control features in-built.

Printers

Printers, particularly laser printers, are now emerging with Energy Star features available as standard. This option is generally a low power operation after an inactivity timeout. The time can vary according to the manufacturer and speed of printer, but is generally 15 to 60 minutes. On receiving data for printing the printer will resume full operation after a brief warm-up period.

Currently, printers drop to between 15 and 40 watt power consumption but the technology is emerging that will allow printers to virtually shutdown completely, only retaining power to the data interface.

To support earlier printers and non EPA featured printers, printer power controlling devices are available that can provide this function externally. Such devices, at this stage however, are designed to operate with a parallel or direct PC connection and are generally not suitable for network connected printers.

Software

Microsoft first released 'Advanced Power Management' capability in Windows V3.11. APM V1.0 was initially intended for Notebook computers to extend battery operation. APM works in conjunction with the PC hardware's BIOS to provide simple user control of the computers hardware's power management functions. APM V1.1 further enhanced the original specification for use with Windows 95 and APM V1.2 now incorporates features specifically designed for supporting 'Energy Star' power management on desktop computers that are able to support the APM specification.

APM defines five power states:

- Full on.
- APM enabled. The system power is managed and the CPU clock is allowed to slow or stop as needed. Device power is managed as needed.
- APM stand-by. No use is being made of the PC, so it's power state and the power state of devices are lowered. The CPU clock may also be stopped. Returning to full on is quick.
- APM Suspend. No use is being made of the PC, so the power level is reduced to a minimum level. A longer time is required for the PC to resume operation.
- Power off.

Application software can also inter-operate with APM to provide the operating system with some knowledge of device power requirements according to the application needs.

Problems generally encountered on a LAN

Network administrators have encountered a number of problems when attempting to implement Energy Star features on computers attached to a network. The most common problem is application errors arising as a result of the computer losing its connection to the network file server. However, users may also encounter a number of other problems as power management features are introduced into an organisation.

- Application errors

  This type of error can be very frustrating for the user. There is often little indication of what caused the error and it generally results in loss of work or the corruption of database information. It is often caused by a loss of the network connection (the workstation communication with the File Server), or by a timeout within the application software because the computer takes too long to respond (such as the start-up of the hard disk drive). These types of errors can result from the application's inability to cope with the energy saving features or compatibility issues associated with Windows APM and the computer hardware or BIOS can cause them.

- Perception of a computer hardware fault

  Some of the Energy Star features, when active, can give an impression to the user that the computer is faulty.
  - 'When I press keys, sometimes nothing comes up on the screen, and then suddenly it all appears.'
  - 'Sometimes the computer is very slow, I click on an option and nothing happens.'
  - 'My screen is faulty, it keeps blanking out for no reason.'

  Such problems are caused simply by users not recognising and allowing for the response delays that can be caused by the Energy Star features. Such problems are not necessarily limited to network users, they can be experienced by any computer user.

- Complex, long computations take much longer to complete.

  Generally associated with complex engineering applications or any application that requires a long time period to complete. The computer going into a sleep mode, slowing the processor clocking speed can cause this. In this case other forms of power saving may be used but the CPU sleep or 'doze' function may need to be disabled.

- User can't print to a network printer

  This most frequently occurs with Windows users on a NetWare LAN but may occur in other Network systems as well. It is caused by the computer going into a 'suspend' mode, losing its network connection and only partially restoring the connection. This generally results in losing NetWare drive mappings (network drives disappearing) and printer connections disappearing. The user can restore the connections but it is best to review how the power-save features are operating and to disable the feature that is causing the loss of the network connection.

Energy Star - feature versus effect

The Energy Star features in most modern computers are reasonably common across the various brands of computer. There are approximately four key suppliers that provide computer BIOS to computer manufacturers and the power-save features are all quite similar.

The power-save features were first designed to reduce the power consumption within Notebook computers to extend battery-running time. However with the emergence of EPA 'Energy Star' and concern for the power consumed by office equipment, these features began to appear in desktop computers.

The key features that are commonly found in both desktop and notebook computers are;

- 'Spinning down' of the hard disk drive or CD-ROM drive.
  After the hard disk has not been accessed for a period of time, the disk drive is disabled to reduce power consumption. Depending on the type of hard disk, the time for the disk to start up can cause some appreciable delay causing a delay in the response to a command or keyboard entry. This affect can also be experienced with some CD-ROM drives causing a 'jitter' or brief freezing to be seen with multimedia CD-ROM based applications.

  With some applications, the time for the disk to start up again may be too long and may result in an application error. Such an error will generally give an option to 'retry' but may still give the user an impression that some form of hardware fault exists.

- Monitor Power Management
  Power management of the display screen is achieved either by a control signal from the computer or by the computer going to a blank screen display (via a screen saver). Some computers also support a 'Dim' display mode, although this has little effect on power consumption.

  If both the computer and the monitor support DPMS (Display Power Management Signalling) then the computer, after a preset in-activity timeout, will signal the display to go into a low power mode. On some computer monitors this may be a two level mode, both displaying a blank screen but the second mode having a lower power consumption but a longer recovery time. Computers that don't support DPMS may use a blank screen saver to initiate the power-save features of the computer monitor. Other forms of screen saver have no effect on power consumption.

  Any monitor power management that is used can result in some negative reaction from the computer user unless they are aware and familiar with the feature. Some 'strange' effects can also result if the user has special screen savers that kick-in after the monitor power-save has initiated. Such screen savers will also defeat the power-save feature.

- System 'Doze' or 'Sleep' mode
  After a period of in-activity on the computer, the 'Sleep' feature will reduce or stop the clocking speed of the processing chip or CPU. This results in a slow-down of the computer and a reduction of power consumption. The 'Sleep' mode may also instruct some peripheral devices to reduce power as well.

This feature can cause a problem on some network systems. On most LANs, the fileserver will 'poll' the workstations on the network to determine what workstations are present on the network. If a workstation is not present and doesn't respond, the fileserver will close down the workstation session, so the workstation server connection is lost. The sleep mode can cause the computer to not respond to a network 'are you there?' request and so the network connection is lost. Modern computers have the ability to select 'wake-up' interrupt settings. This allows you to set up the network card interrupt to wake-up the computer and respond to the request. Some modern network cards can also be set to respond to network requests without having to 'wake' the computer.

- 'Stand-by' mode
  In this mode the computer reduces all power consumption to a minimum level, shutting down almost all activity. From this mode the computer is able to respond reasonably quickly to a request while reducing power consumption to the lowest level. Like the 'Doze' mode, unless the computer is able to monitor activity on the network card then this mode may cause a loss of network connection. Unless correctly set-up this mode of operation should be disabled.

- 'Suspend' mode
  Mainly associated with Notebook computers but may also be seen in desktop computers that have APM V1.2 capability. Such computers are also able to support 'Soft Power Off' which shuts down the computer power when exiting the operating system without having to switch off the power to the computer.

  After an extended delay (generally after other power-save features have been activated) the computer will save the memory contents to a special file on the computer hard disk and will then perform a total power shutdown. On power up the computer will restore the memory contents from the saved file so restoring the state of the computer back to the same point prior to suspending.

  This can cause considerable problems on a network-connected computer, since the shutdown of the computer will result in a loss of the network connection. The connection will not be 'resumed' to the same point when the computer is powered back up even though the application software will still assume that the connection is the same. This results in serious application errors, loss of saved information or in the case of shared file or database applications, it can cause serious data corruption problems.

  Modern computers and Notebooks may include features to keep the network card active when the computer is suspended, but the network card must also support 'keep alive' functionality to avoid losing the network connection.

  It is recommended to either disable this function when network connected or to choose and configure the appropriate equipment options to avoid this problem occurring.

Network administration considerations

A large portion of the 'cost of ownership' associated with any computer network is the cost of administration and management. Although the reliability of computer systems is improving, the rate of change on a computer network is also increasing, as is the complexity of the hardware / software mix.

To add to the complexity of maintaining a suite of computer systems, the amount of disk space required to run modern application software is also rapidly increasing. It is no longer practical or desirable to run application software across the network. Desktop workstations now have their own hard disk - often with large capacities so that application software is now installed down onto the desktop workstation.

Maintaining the user desktop software, conducting upgrades, and trouble-shooting problems are all becoming an increasingly difficult task for the network administrator. It is no longer practical, even on a moderately sized network, to move around from one PC to the next performing administration tasks. This, together with the need for timely management information, such as inventory, about the computer network, means that there is an increasing need for centralised network administration and management.

With the size of modern application software, and the need to minimise disruption during business hours, a good deal of the on-line network administration will be conducted at night. This represents a problem for organisations that have a policy of switching off computers at night. Soon many will require computers to be left on during the night. As well as the issues associated with energy saving, such a practice also represents other problems such as fire risk, increased heat production placing extra demand on air-conditioning, and the shortening of equipment life.

With correct set-up of the Energy Star features it is possible to allow workstations to remain active over-night while still reducing power consumption to a minimum. The extent to which this will be possible will depend on the mix of hardware and software being used, particularly the vintage and the compatibility of the two areas.

If using Windows 95 or Windows NT V4 then the functions of APM V1.2 can be used together with hardware Energy Star features. Some effort will be needed to find the configuration that operates best with the hardware / software mix, but significant energy saving can be achieved while the equipment is able to respond and participate in administration tasks.

As a minimum, screen power can be switched off, either manually or, if the monitor supports Energy Star functions, then by simply using a blank screen saver. This will trigger the monitor into the power-save mode (other screen savers will not trigger the power-save and can work to defeat power-save functions). This reduces power consumption and the risk of fire.

The key power-save functions that can be used are;

- ‘doze’ or sleep function with interrupt set for the network card interrupt setting
- ‘Stand-by’ with network interrupt set-up (if this does not cause network connection loss)
- Hard disk spin down
- Monitor automatic power-save or a policy of switching off monitors at night.

Implementing Energy Star features on existing network workstations

Most offices will already have an investment of computer equipment, some that will support Energy Star features and some that may not. The compatibility of these features with software may also be an issue.

With a small investment in effort, it is a reasonably simple task to determine how best to configure the energy saving features to operate successfully. Some user education or awareness will also be required but this will also require little effort beyond a memo or brief note explaining what they can expect and how they should shutdown and start-up their PC system.

Power saving features should be tested for any problems, network or workstation, which might be caused by enabling the various features. They should also be tested for user acceptance. If timeout periods are set too short they can prove frustrating for users, and screen blanking or extra response delays, while a person is attempting to conduct their work, can be counter-productive. Without care, any saving made can soon be lost through a loss in productivity and user confidence.

User awareness and education is very important. Some features can be quite transparent while some will be noticeable to the user, such as screen blanking and a brief start-up delay when they return to their workstation after not using it for a period. If the user is aware of these aspects, and the reason for their introduction, then there is seldom any complaint.

When trouble shooting the Power-save functions, begin by introducing each function in turn until the offending feature is found. It may then be possible to find why that function is causing a problem and to correct it.

The flow diagram in figure 1 provides a guideline to setting up energy saving on existing PC systems.

Figure 1: Implementing Energy Star on Existing network workstations.

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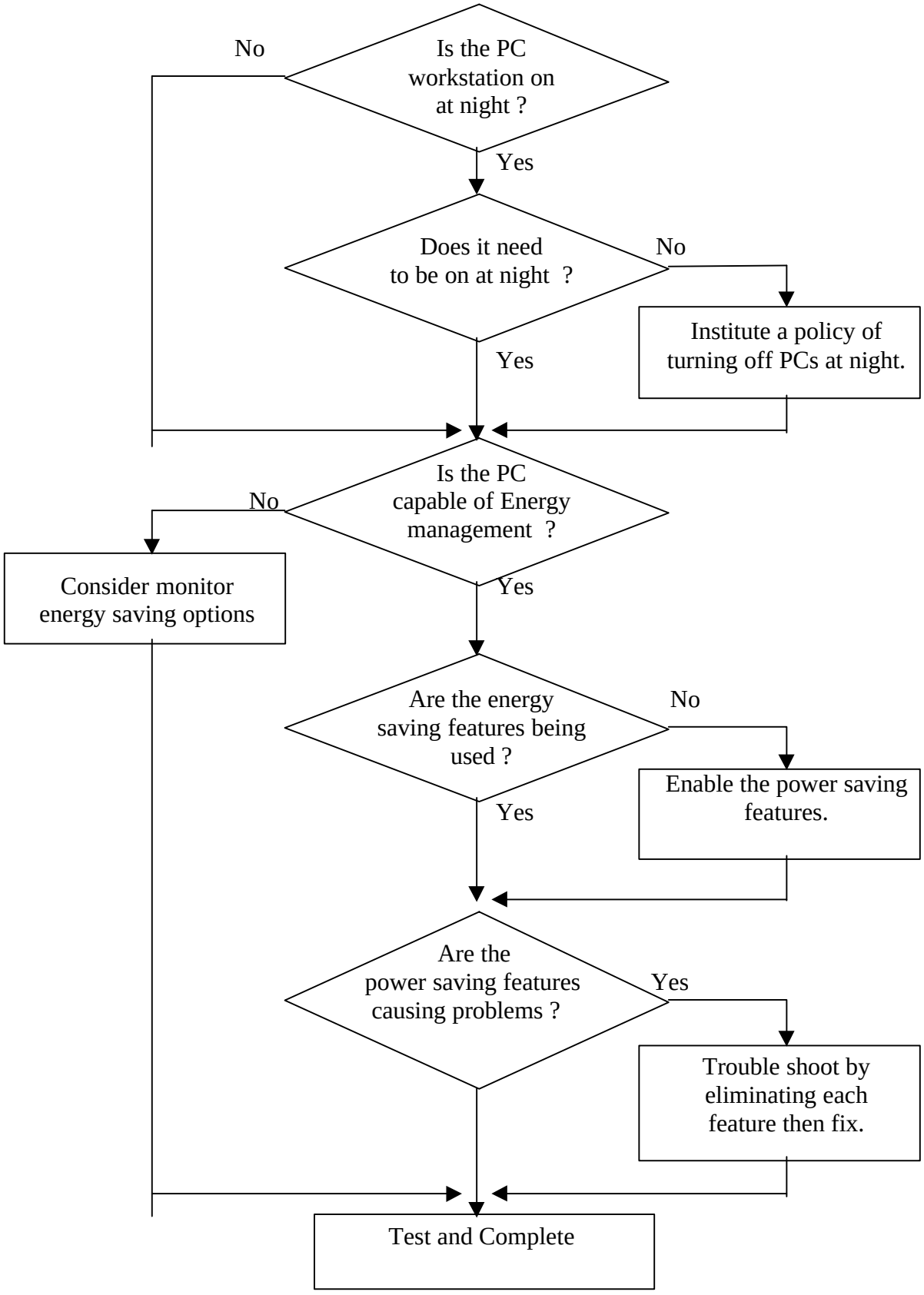

Introducing new equipment with Energy Star enabled

EPA Energy Star compliance requires that a manufacturer supplies the equipment with the Energy Star features enabled. However, some vendors may choose to disable the features before sending to the customer.

Energy Star compliance should form part of the selection criteria when choosing new equipment, even if there is not an intention to immediately implement it's features. The compatibility and the effects of the Power-save features, particularly with the operation of the equipment on a network, should be thoroughly tested.

It is likely that you will need to make adjustments to the features provided by the supplier. The accepted defaults may well cause you problems once the PC systems are in operation on the network. If you need to go to each and every installed PC and change how it is set-up, this could take considerable time.

Once you have tested and found a configuration of the features that work well on the network you should be able to persuade your vendor to supply the PC systems with that configuration preset for you. Otherwise the set-up of the power management functions will need to be conducted as part of the 'pre-configure' and rollout process.

To simply turn-off the features could create a need for considerable work later, once network management functions require PCs to be left on at night and organisation management begin asking questions about fire risk and excessive power consumption.

A variety of new standards are emerging with regard to power management in computer equipment. As a minimum, new equipment should be EPA Energy Star compliant. If you intend to use Windows 95 or Windows NT operating systems, then you should check the compatibility of the equipment with Microsoft's APM V1.2. Microsoft have released a specification called 'PC-95' that defines a number of guidelines for PC suppliers and purchasers to assist with choosing equipment that is compatible with Windows 95. Microsoft also publish a Windows NT compatibility list that provides a list of manufacturers and PC models that have been tested for Windows NT compatibility.

Future Initiatives

A number of key initiatives are in development by manufacturers which will be of significance to forward thinking organisations that are taking steps to reduce the power consumption of office equipment. Many of these features not only have energy saving aspects but will also provide many user benefits as well.

PC Power Management

Further development is taking place by Microsoft as a flow on to the APM specification already in place. As part of Microsoft's 'OnNow' program, Microsoft is working with Intel and various PC manufacturers to define a new specification called 'Advanced Configuration and Power Interface (ACPI). This greatly enhances the power management functionality already defined in the APM specification to provide the operating system with far greater control capability over the PC power functions.

Monitor Power Management

Most PC monitors today use the Cathode Ray Tube (CRT) which is both bulky in size and uses a significant amount of power. The technology race is on to provide an alternative to this form of display technology. LCD screens have been in use on Notebook computers for some time but are still too expensive to use as large displays for desktop computers. An alternative form of CRT tube, which is extremely thin in shape, and requires significantly less power, is also being developed. It is likely that one of these two technologies will begin to emerge as a cost-effective alternative to the standard CRT display.

Power Management on Network PC Systems

The power management initiatives mentioned above will incorporate a number of features to ensure the problem free operation of PC workstations on networks. A number of Network card and Network chip set manufacturers, such as Digital, are already incorporating many features in their network chip sets that will be able to take advantage of this new technology. This mainly centres on the ability of the Server operating system to inter-operate with Network Management software and send out 'Wake-up' packets across the network. This is received by the workstation network card, which will then wake up the workstation operating system to initiate the required interaction. The network card would handle other forms of 'Are you there?' type of traffic without the need for any involvement by the PC itself.

Conclusion

For many network administrators, the arguments in favour of enabling the power-save features on their equipment may not be strong enough in view of the work required and the hassles that can result. Ultimately the network administrator wants to provide the best computer tools for his or her organisation with the minimum of problems and for the least cost. Unless he or she can identify some direct and significant cost or productivity benefits, they are unlikely to take too much action.

As mentioned earlier, the purpose of this report is not to justify why organisations should consider enabling the Energy Star features but rather to examine the features, what they do and what affect they can have on the network operation of a PC computer. It is up to the administrator and organisations management to decide whether or not to implement energy saving practices and policies.

One aspect that may well make power management of computers an important consideration for organisations is centralised network management.

For most organisations with more than thirty network PC computers, the option of using network management is going to become increasing viable. Significant focus will come about on examining the real 'cost of ownership'. A high proportion of this cost can be attributed to the administration and on-going support of the networked computer. Centralised network management and administration will play an increasingly significant roll in reducing the cost of ownership. This will bring about the need for users to either leave their PCs powered on all night or to perform a 'soft' power down, so that network management can take place outside business hours.

To leave PCs fully powered on all night not only represents a waste of energy, but also presents a fire risk and is proven to reduce the life span of the computer. Organisations can institute a policy of powering down monitors at night, but this relies on the user cooperating and remembering to do so. A far more effective method is to use the power management features provided in the equipment.

So, whether you implement Energy Star features now and take advantage of the immediate benefits, or you implement the features later when it becomes essential to do so, it is inevitable that you will need to put some form of power management in place in the not too distant future.

The key aspect is that, even if organisations do not wish to immediately implement the Energy Star features, they should begin to consider the benefits of doing so, what effort would be required and to be aware of any issues that will need to be addressed. They also should begin to give closer attention to power management when considering the purchase of new equipment and to test the compatibility of the features with their network interface cards and their current or planned operating system software.

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